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EXISTING RAILWAY WORKSHOPS AND FACILITIES IN SELECTED AFRICAN COUNTRIES*

prepared by

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ABSTRACT

The principal purpose of this mission was to assist the Union of African Railways in improving the facilities for maintenance and repair of their rolling stock. Based on a fact-finding mission to selected African countries, a study of present-day framework policies and existing facilities was carried out. It was found that up to 50 % of rolling stock was actually not fit for operation due to a lack of spare parts for tractive stock, passenger coaches, and goods wagons, including a lack of spare parts for the mechanical equipment in the repair and maintenance facilities. Apart from the very specific conditions of railway operation in Africa, the usually outdated or difficult tracks cause ever-increasing repair costs.

Some workshops must have their mechanical equipment updated. A majority should have a policy introduced, in which prospective sources for spare parts for all equipment are located. With regard to the rolling stock, it is highly recommended that the responsible authorities provide the railways with the means to ensure the future supply of necessary spare parts. This measure will reduce the considerable quantity of equipment in need of repair due to long delivery times or financial problems. In some cases, there should be an effort to reduce the variety of equipment types. Equipment oredered for the first time has very often proved unsuitable for African operating conditions. The time for establishing a proper railway industry in Africa has, with very few exceptions, not arrived yet, and awaits solution of the aforementioned basic problems with close international cooperation.

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I. INTRODUCTION

A. Purpose of the Mission

At the request of the Union of African Railways (UAR/UAC) directed to UNIDO, a study was to be carried out to assist the UAR in upgrading the facilities for maintenance and repair of rolling stock and equipment, based on a fact-finding mission to selected UAR Member Administrations. The study was to report the actual situation and problems of the railway workshops and facilities. Based on this up-to-date information, recommendations were to be made on:

- the improvement and expansion required for the local production and repair of rolling stock;
- a framework of policies and strategies for the development of the railway industry in Africa;
- a possible approach for promoting cooperation among African countries, but also generally among other developing countries.

The findings of this mission were also intended to give some recommendations for further action to be taken by Afican countries in cooperation with the UAR and UNIDO. As stated in the Resolution 31/160 of the UN General Assembly, the assistance to African railway engineering is one of the most urgent priorities of the UN TRANSPORT AND COMMUNICATIONS DECADE FOR AFRICA 1978-1988 because of its direct relationship to the overall and social problems on that continent.

B. Schedule of Visits

Planning and Selection

In order to obtain an objective and representative survey of the aforementioned problems, several UAR Member Administrations

in various regions of the continent had been selected by the General Secretary of the UAR, Mr. DIAGNE, and the UNIDO Engineering Industries Section in Vienna. Within the total 1.5 month duration of this mission, a schedule of technical visits to the repair and maintenance facilities of the repair and maintenance facilities and the railway administrations of the following countries was planned, as follows:

- Zaire : Kinshasa, Headquarters of the UAR
- Kenya : Nairobi (Kenya Railways KR)
- Zambia : Lusaka - Kabew (Zambian Railways ZR)
- Sudan : Khartoum (Soudan Railways Corp. SRC)
- Cameroon : Yaounde (Regie Nationale des Chemins de Fer du Cameroun, RNCFC)
- Ivory Coast : Abidjan (Regie des Chemins de Fer Abidjan-Niger, RAN)
- Senegal : Dakar-Thies (Regies des Chemins de Fer du Senegal, RCFS)
- Mali : Bamako (Regie des Chemins de Fer du Mali, RCFM).

Between March 22nd and April 21st 1984, the mission planned to conduct, if possible:

- interview with Chiefs of Mechanical Engineering
- interviews with specialists in repair and maintenance
- visits to depots and workshops where the different categories of maintenance and overhaul are done, including interview to learn their problems.

It was, fortunately, possible to carry out the greater part of this program and to complete the journey between March 22nd and April 21st. Travelling difficulties involved in the planned visit to Cameroon made in necessary to reschedule the envisaged plan slightly, but it was possible to replace the Cameroon interview by an interview regarding Benin.

Effected Visits

The following tour of countries and their railway adminstrations actually took place (see APPENDIX 1):

22-27 March	ZAIRE, Kinshasa	UAR-Headquarters Railway Administration OANTRA Interview "Benin"
28-30 March	KENYA, Nairobi	KR
31 March- 3 April	ZAMBIA, Lusaka and Kabwe	ZR
4-9 April	SOUDAN, Khartoum	SRC
10-13 April	IVORY COAST, Abidjan	RAN
14-18 April	SENEGAL, Dakar and thies	RCFS
19-21 April	MALI, Bamako	RCFM

At the beginning of the mission, a very helpful address of recommendation was prepared by the General Secretary of the UAR to all concerned Member Administrations, explaining the purpose of the visit (see APPENDIX 2).

In order to obtain an up-to-date survey on all problems useful for comparison with other studies, a QUESTIONNAIRE was prepared by the author, and it is this on this questionnaire that all interviews and visits were based. The questionnaire aimed at obtaining:

- general, basic information on those network visited (updated)
- information about special operating conditions, which related to maintenance and repair
- the framework policies for maintenance and repair and the rules of these railways
- details from facilities visited regarding repair and maintenance and their problems.

This questionnaire was the basis for the elaboration of the Table-Appendices, which contain detailed technical information and figures.

The contacts in detail were:

Zaire

Headquarters of the Union of African Railways

- A general discussion was held with the General Secretary of the UAR, Mr. A. DIAGNE, on further details of the mission concerning the expected results, and concerning general policy of the UAR.
- Detailed discussions took place with Mr. SAHOUEGNON, Technical Manager of the UAR. He kindly revised the prepared questionnaire to better cover African conditions of railway operation, maintenance and repair. A UAR recommendation (3002/80) on maintenance and repair of passenger coaches and goods wagons is already available and should be overserved by UAR Members starting on January 1, 1985, at least for international traffic; its principles were taken into account during interviews. As locomotives are not expected to traverse borders in coming years, national rules must be accepted. Nonetheless, there was a certain contact amongst Members during a recent symposium.
- Mr. SAHOUEGNON, as a former member of the BENIN Railways Board (OCBN), kindly gave, as a kind of test for the questionnaire, an in-depth interview for the Benin administration, which therefore could be fully included.
- the National Transport Organization "ONATRA", Kinshasa, was visited regarding two railway lines in the western part of Zaire. An interview was held with the Technical Manager, Mr. PROUVEUR, along with visits to Kinshasa workshops and depots.

Kenya

The Kenya Railways Board, Nairobi, Department for Mechanical Engineering were visited; Technical Manager Mr. NYUE was interviewed, as was Mr. OCHERE for general policy in maintenace and repair. Detailed visits took place to all sections of the large KRCentral Workshops working for Eastern African Railway System, including detailed discussions with its manager Mr. MIMANO and responsible engineers and foreman.

Zambia

The Mission included a visit to Zambia Railways Board and the Central workshop at Kabwe (about 130 km from Lusaka). Mr. SHANKAYA, Chief Mechanical Engineer ZR, was interviewed in detail, and Lusaka Railway Station and its rolling stock were inspected.

Soudan

Public Relations Offer of SRC Mr. HASSANEIN discussed overall information on SRC and its main problems. Following a principal contact with the General Manager of SRC Central Region, Khartoum, the extensive workshops for passenger coaches and goods wagons were examined. In addition, the Khartoum locomotive depot, with Manager Mr. HASSABALLA and his engineers, were visited. Very helpful additional information was made available in the UNDP-UNIDO Field Office, Khartoum, by the SIDFA, Dr. Harju.

Ivory Coast

The mission met with Mr. KONATE, General Manager of RAN, who kindly provided the author with a written statement describing the severe difficulties of this traditional African rail network (see APPENDIX 3). This talk was followed by discussions with Mr. DIARRA, Chief Mechanical Engineer of RAN, regarding general

policy of maintenance and repair. Finally, the mission travelled to the Abidjan Central Workshop of RAN, which handles all types of rolling stock. A detailed discussion took place with Mr. Akichi, Head of Workshop in Abidjan, and with responsible chiefs and foreman of different sections.

Senegal

After a short visit to the Commercial Management Headquarters of RCFS in Dakar, an extended visit was made to the RCFS Railways Board in Thies (about 80 km from Dakar). After a general discussion with Mr. VENAULT, Ass. General Manager, and Mr. NDIAYE, Director for General Studies, The central workshops (also in Thies) with all of their sections were toured, and all usual interviews were conducted.

At the UNDP-UNIDO Field Office in Dakar, contact was made with another current UNIDO project, "Dakar-Marine", concerning possible cooperation between shipyard workshops and railways in fabrication of certain equipment.

Mali

The Mali Railways Board, Bamako, was visited, involving talks with Mr. SIDIBE, RCFM Ass. General Manager, and Mr. DIANE, Technical Manager of RCFM, in which the necessary overall information was obtained. A visit to the RCFM Railway Workshop and Depot of Bamako provided further details on the problems of this administration.

II. STUDY OF VISITED WORKSHOPS AND FACILITIES

A. General Remaks on Repair and Maintenance

The density of African railway network is very low. The network is made up of a series of secondary networks, mostly national in character and often independent. They do not all have the same technical specifications. In particular, there are nine gauges in Africa, of which only three are widespread: the normal European gauge (1.435 m) is used in North Africa, making up 14,5 % of the African network; the so-called Standard African Track gauge (1.067 m) is that of the South African countries' networks, including Zaire, Soudan, Ghana, and Nigeria (61 %); and a metric gauge (1.000 m) is utilized in West and East Africa (19 %).

A great part of the overall system was built about 80 years ago. This fact implies not only a variety of superstructures and fixed installations, but also, of course, very different rolling stock.

Most of the interviewed engineers stated that most or all of the track is in very bad condition. Hundreds of kilometers are still not ballasted, or need realignment and reinforcement. These inadequacies interfere heavily with maintenance and repair of rolling stock. There is naturally a much higher level of "casual repairs" caused by accidents and technical failures. This probably also causes a higher frequency of periodic maintenance and overhaul.

The present study did not take into account the normal inspection work done in main staions, but only the work done in special facilities for rolling stock. This stock was divided into

categories: tractive stock including line-locomotives, shunters, and railcars; passenger coaches; and goods wagons. There are two basic types of facilities for maintenance and repair work, depots and workshops. Generally, depots are more widespread, taking care of minor work from certain technical inspections to light overhaul and light casual repair. In contrast, workshops perform periodic overhaul work not delegated to depots, all heavier casual repair caused by accidents and technical failures, and some modernizations or modifications. Some of the workshops visited are capable of some degree of selffabrication of large railway equipment. Both workshops and depots may specialize in certain types of rolling stock, or may be all-around facilities.

B. Basic Information on the Visited Railway Network

Taking into account that only fairly old statistics were available to the author at the outset, the QUESTIONNAIRE began by asking for basic up-to-date information on:

- details of actually operated lines
- total personnel of the whole network
- present rolling stock (in units)
- present maintenance and repair facilities and the type of rolling stock they process. If known, the total size of these facilities and their total repair and maintenance personnel is indicated.

All the information abtained is tabulated in APPENDIX 4. Please note that there are relatively few specialized depots and workshops, but very many all-around facilities in capital cities and population centers. The counts of present rolling stock also include the non-working fraction.

C. Special Operating Conditions

Special operating conditions are factors in the framework policy for repair and maintenance of railway rolling stock. Apart from track age and conditions, the African continent shows a widespread variety of different landscapes and climates, ranging from nearly Mediterranean conditions, to steppes and deserts with heat and dust, to hot tropical jungles with nearly 100 % humidity. All of these exist apart from variable gradients and many other factors. therefore, the QUESTIONNAIRE included some queries on the climate; it can be seen that many trains have to pass through very varying climatic regimes. Finally, some essential specifics of rolling stock interfere with maintenance and repair work, namely the variety of equipment types used, their requisite spare parts and operating conditions, as well as the equipment age and provenance. Age, for example, affects the frequency of overhaul and creates problems with supplying spare parts, which at times must even be hand-made. Foreign provenances can cause problems in terms of delivery.

Details are listed in APPENDIX 5 (TABLE), Special Operating Conditions.

D. Repair and Maintenance Policies of These Railways

It was found that some basic differences in framework policy for rolling stock maintenance and repair arise from previous technical infrastructures. Some western African and central African Networks use French railway technologies. Some networks in East and South Africa have British technologies, though influenced also by the technologies of suppliers.

As already mentioned, repair and maintenance work is done in

railway depots and workshops. Depots generally perform periodical inspections, safety checks, and light overhauls. Each administration applies certain categories for the three basic types of rolling stock (tractive stock, passenger coaches, and goods wagons). The criteria for input form the maintenance schedule, which can be based upon time or kilometers travelled.

Workshops are generally much better outfitted than depots and they are responsible for:

- periodic overhaul and repair
- "casual repair" of all heavier technical incidents and accidents, which was found to be common practics in Africa
- a considerable part of modification and modernization work, including self-fabrication of parts and complete elements.

For periodical overhaul, they have to follow the applicable rules for repair and maintenance, given in categories of work, starting with general maintenance work and ending with heavy or general overhaul, where the vehicle leaves the workshop "like new". As for the depots, there are different criteria used to decide the repair process for equipment, involving either time (engine hours) or effected run (kilometers).

Apart from this periodical work, which can be planned over months and years, all casual repairs must occur. Technical failures, incidents, and accidents have grown to make up a high proportion of work, due to problems of track or of imported material unfit for African operating conditions.

Fortunately, it was found that most of the workshops visited take the initiative to fabricate certain spare parts, interchangeable units, special tools, or even complete bodies for coaches

or goods wagons. Moreover, great modernization and modification work was observed, from brake systems and couplers to complete exchange of Diesel motors. APPENDIX 6 shows in tabular form the maintenance and repair work done according to the imposed categorization and scheduling.

E. Details of the Facilities Visited

Due to shortness of time, only the most important factors about visited depots and workshops could be incorporated into the questionnaire. It was not the intention to describe them in minute detail, but to obtain an overall survey of their work and their problems in relation to the repair and maintenance policies of their networks.

The three tables APPENDIX 7 show, in chronological order of the visiting schedule, the main factors:

- kind of facilities and location, age and staff of the facility;
- for which kind of rolling stock the facility is considered responsible;
- the overall impression of the facility and its technical equipment, including tool machinery, lifting devices, specialization sections, storage, some indication of internal organization.
- indication of the typically used working procedures. Generally, these can be split into two procedures. In the first, the unit remains in one place while parts are dismantled and either exchanges, or repaired and refitted. This procedure was mostly found in the all-around workshops of smaller networks. In the second method, the online system, the object moves from one working procedure to another, each performed by specialized groups. It was found that, as a rule, all workshops use or try to use

the method of interchangeable units and components in order to limit the time of immobilization. Unfortunately, it was also seen that repair work had to take place piece by piece, and the object had to wait;

- in order to get a general idea of the effective working capacity of railway workshops, an attempt was made to determine the quantity of different maintenance or overhauls operations done each year on the verious kinds of rolling stock equipment;
- the methode used by all administrations for control of maintenance and repair costs were examined. These methods usually involve having foremen control the number of manhours, and specifying the used spare parts and components;
- a certain interest was also given to the problem of an efficient quality control of the repaired material, a control which seemed similar everywhere and fairly satisfying;
- finally, remarks are given along with problems indificated by the workshop engineers and foremen. They show problems with equipment in the facilities (outdated machinery, lack of spare parts for tool machinery or lifting devices, requests for certain improvements or modernizations), with the spare parts, interchangeable units, and components of rolling stock (financial problems, long delivery periods, specific work performed outside, high prices), and, last but not least, problems with rolling stock ordered for the first time from abroad, which is often not fit for African operating conditions. The direct relationship between the track problems and needs and frequencies of repair have been underlined nearly everywhere.

It must be noted that many workshops undertake efforts to do work in modification or modernization, mainly on brake systems, bogies and axles, complete exchanges of Diesel motors, fixing of new or other bodies on existing and renewed chassis, or modifying of old-fashioned equipment from goods wagons to container transports. The final impression was that, under the given circumstances, people try to do their best.

III. RECOMMENDATIONS

A. Improvement and Expansion of Workshops and Facilities for the Maintenance and Repair of Rolling Stock and Equipment

In almost all locations, the following measures should be undertaken with the highest priority:

- outdated equipment of depots and workshops must be replaced or brought up to date;
- a prospective supply of spare parts must be assured for the tool machines of the depots and workshops, starting with well-timed budgeting and ordering;
- where necessary, reductions should be made in machine tool types for each procedure, in order to diminish spare part storage problems;
- a rapidly implementable strategy should be introduced for obtaining a sufficient supply of spare parts and interchangeable units to depots and workshops, thus assuring quick and efficient repair. The necessary financial means must be on hand at the time of agreement. Good contracts with suppliers are those which specify the deliveries within reasonable times and at reasonable costs. Taking into account the overall economic and social aspects of railways in Africa, a certain amount of thought about profit is especially necessary. Having up to 50 % of the whole stock waiting for repair certainly procedures financial losses, as well as a loss of confidence by users and clients. This is true whether the difficulty is a lack of stock replacements, or lack of parts for repair equipment;

- the veriety of locomotive, coach, and goods wagons types should be reduced where possible; for the sake of modernization, too, an effort should be made to reduce the variety of installed new units or elements, such as Diesel motors;
- it was found that, very often, equipment imported for the first time was not suited for operating conditions in Africa: some was not sufficiently robust, some was inappropriate to the climatic conditions. It was felt that additional experimental and research work is needed in this field, taking into account all relevant operating conditions in the call for bids. Further, bids and equipment should be made subject to rigorous testing by the railways;
- certain workshops in centers of linking network could be expanded in order to provide more self-fabrications, and thereby more independence from problematic foreign suppliers.

B. Framework Policies and Strategies for Development of a Railway Industry in Africa

Based on the results of this report, one can unfortunately not see the conditions for installation of a proper railway industry - one with self-fabrication of rolling stock - in Africa. Much more serious problems must first be solved in the present decade. The existing equipment should be made to run on satisfactory track before new steps are undertaken. In addition, there remains the problem that most networks are not linked together, often using different gauges with a variety of types of rolling stock.

The first cell for development of a proper railway industry in Africa could be a central workshop in a region where networks are linked and international traffic is handled. Cells could

be developed, then expanded to enable production of material in greater quantites. Within the near future, and until the establishment of certain parts of the network "Master Plan" (APPENDIX 1), there will remain a certain dependence on imported equipment.

C. Training Programs for Local Personnel

The following recommendations and requests were presented by the interviewed railway specialists:

- the upper-level technicians should be enabled to observe and study new technologies and materials in the so-called "developed world". This process must, however, take into account differences in railway working conditions. A visit to a sophisticated modern workshop of electric locomotives in a high-density railway network cannot be very instructive. Instead, a middle ground must be found, and the managers of AFrican railway workshops must be able to study developments in repair and maintenance technology with a certain regularity.
- the opinion was expressed several times that foreign training of skilled workers (particularly foremen) did not seem to be very helpful. These people trained and worked under very different economic and social conditions, often causing difficulties and discontent upon return to their former environmen. Local training is preferred, and there was no request for the addition of specialized schools or training colleges to the framework policy.
- there was, on the other hand, an interesting request: foreign suppliers should be required to study the local operational conditions for at least one month before bidding and/or supplying commences.

D. Common Approach Need for Promoting Cooperation among African (an other Developing) Countries

It was found that there are still considerable differences amongst African railway networks concerning repair, maintenance, and fabrication of rolling stock, dating often from older times and their infrastructures. A common approach must be found, for this report indicates that their working problems are mostly quite similar.

The Union of African Railways must be supported in its remarkable efforts to bring railway networks together to discuss their problems. First steps have been undertaken by, for exemple, preparing repair and maintenance guidelines for passenger coaches and goods wagons (Technical Leaflet 3002/1980). At a symposium in Bamako, in September of 1983, an effort was made to assemble experiences in repair and maintenance of tractive stock. All such initiatives must be supported and intensified. At least the international traffic vehicles should be submitted soon to fairly uniform repair and maintenance standards.

In order to settle some of the recent problems with newly-ordered equipment unifit for African conditions, a kind of UAR Office for Research and Experiments might possibly be installed. Such an office would allow close cooperation between representatives ot the main regions in developing bidding and supply rules, in clearly defining problems, and in exchanging experiences regarding tested solutions. The office could also be developed into contact point for other developing countries with similar operating conditions.

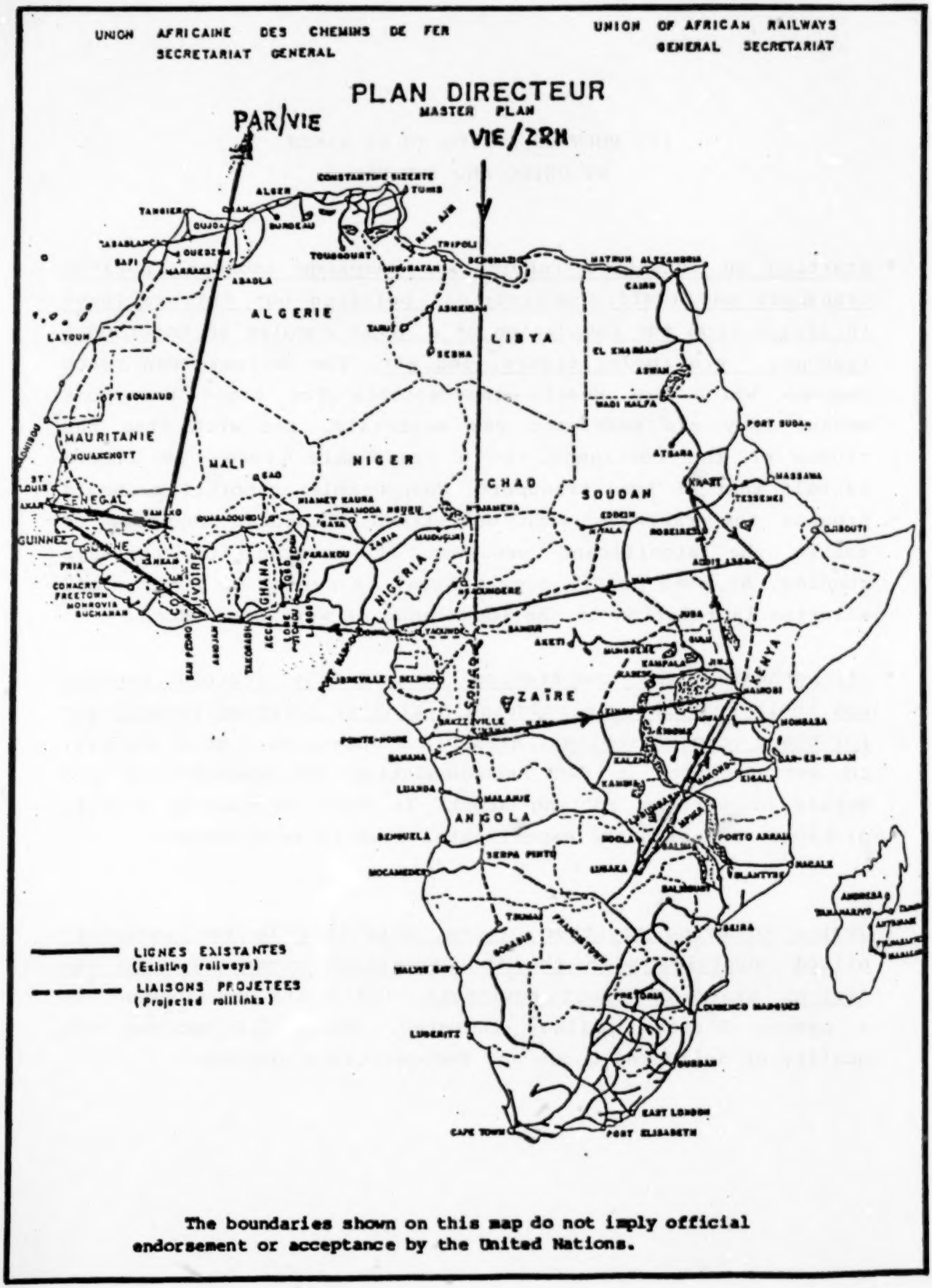
IV. FURTHER ACTION TO BE TAKEN BY UNIDO AND THE UAR

* Starting an intensive information campaign amongst involved transport and traffic ministries, pointing out that railways in Africa from the foundation of a great complex of intermodal transport, via roads, rivers, and air. The railways can reach regions which are nearly inaccessible for other transport means; they can transport raw materials, and with them the riches of the continent, at a reasonable proce - as little as half that of road transport. Responsible authorities should provide the railways with well-timed financial support, to settle the significant problems of keeping the railways running. At some point, too, a study is needed of lower staff salaries in relation to the importance of work being done.

* Strengthening the cooperation amongst the African regions and their networks, introducing a kind of "African Technology" for their common problems. APPENDIX 8 shows, as a good example, an extract from a UAR Recommendation for Maintenance and Repair of certain rolling stock. In oder to clearly specify problems, research and experimental work is recommended.

* Trying to bring together present suppliers in the industrialized countries with the industrialized countries with the African users of their equipment. Until the development of a proper African railway industry, this will improve the quality of delivered goods and reduce future problems.

APPENDIX 1



The boundaries shown on this map do not imply official endorsement or acceptance by the United Nations.

APPENDIX 2 : TABLE : BASIC INFORMATIONS ON VISITED RAILWAY NETWORKS

Country	Name of Railway Network	Operated Lines				Total Personnel	Present Rolling Stock					Present Facilities for Maintenance and Repair and Modernization												
												Depots						Workshops					Total Surface m²	Total Personnel
		Gauge mm	Total Length km	% ballast	Max Axle Load T		a Line Locomotive (all Diesel)	b Locos for Shunting (all Diesel)	c Railcars (all Diesel)	d Passenger Coaches	e Goods Wagons	place	for a	for b	for c	for d	for e	place	for a	for b	for c	for d	for e	
ZAIRE	ONATRA	1067 616	365 136		12 8	3700	30	47	2	137	3066	Kinshasa Boma	X X	X X	X	X	X	Kinshasa Mbanza-Ngungu Matadi	X	X	X	X	X		1300
BENIN	OCBN	1000	579		13,5	1600	40		8	46	428	Cotonou Bohicon Parakou	X	X	X	X	X	Cotonou	X	X	X	X	X	9100	800
KENYA	KR	1000	1265			25000	100	60		190	6700	Nairobi Kisumu Nakuru Eldored Athiriver Voi Mombasa	X X X X - X X	X X X X - X X	X X X X - X X	X X X X - X X	X X X X X X X	Nairobi	X	X	X	X	X		2800 Nairobi total = 51 % of Staff in Mech. Eng.Dept.
ZAMBIA	ZR	1067	1104		18	8400	68	12	3	84	8400	Kitwe Ndola Livingstone Chona Kafwe small	X X X X	X X X	X X X X	X X X X	X X X X	Kabwe	X	X	X	X	X		800 Kabwe
SOUDAN	SRC	1067	4785	50 %	16	35000	158	60	3	600	7000	Kassala Babanousa Kosti Port Soudan Khartoum Atbara	X X X	X X X	X X X	X X X X X	X X X X X	Atbara Khartoum	X	X	X	X X	X X	80000	5000
IVORY COAST	RAN	1000	1171	100 %	15	2700	43	36	30	171	1730	Abidjan Bonake Bobodionlass Ongadongou	X X X X	X X X X	X X X X	X X X X	X X X X	Abidjan Bobodionlasso	X	X	X	X	X	35000	500
SENEGAL	RCFS	1000	1034		15	2500	26	21	6	116	680	Thies Dakar	X X	X X	X X	X	X	Thies	X	X	X	X	X	74000	400
MALI	RCFM	1000	641	100 %	15	2400	25	5	4	42	350	Bamako Toukoto Kayer	X X X	X	X	X	X	Bamako Kayes	X	X	X	X	X	24000	450

APPENDIX 3 : TABLE SPECIAL OPERATING CONDITIONS

Administration	Tracks		Climate	Specifics Rolling Stock								
				Tractive Stock			Passenger Coaches			Goods Wagons		
	dated from	Remarks		Nr. Types	Age	Provenance	Nr. Types	Age	Provenance	Nr. Types	Age	Provenance
ONATRA	1930	Gradients Unsatisfying condition	Tropical 28-30° C to 100 % rel.Hum	4	up to 30 years	USA CAN D	4	up to 40 years	GB, D		up to 40 years	many different
OCBN	1900 1936	Renewal required	Jungle near Coast later Steppe, hot, dry, dust	2	1964 to 1981	F	diff.	1960 to 1980	diff.	diff.	up to 35 years	diff.
KR	1899 and later	no special remarks given	Jungle near coast, Steppe, Gradients	8	some 1950 - 55 many after 1971	GB USA D						
ZR	1905 to 1957	no special remarks given	Steppe	2	up to 15 years	USA D	1	8 years	JAP	diff.	diff.	diff.
SRC	1897 and later	mostly very bad; great. parts not ballasted	From dessert to Steppe Heat, dust sand	6	1959 1970	GB USA D JAP	3	also some from 1914	HUNG GB Self-Fabric	many	up to 1914	NL E GB India etc.
RAN	1906 1955	part 1906 bad many rectifications necessary	Jungle near coast then Sahel-Steppe 41°, dust	6	1972 and later	F CAN D	2	1975	F	2 basic	1945 and later	F CAN
RCFS	1885 1923 1960	bad condition Renewals rails ballast necessary	Steppe to 45° C sand dust	6	1960 and later	F D CAN	4	1960 and later	F E	8	also very old	diff.
RCFM	1880 1960	Renewals necessary welding, ballast, rectification	Sahel Steppe desert up to 45° dust sand	7	1956 and later	F CAN D	2	1952 1975	F	3 basic	1938 1969 1976	diff.

APPENDIX 4 : TABLE BASIC PRINCIPALS OF WORK DONE IN RAILWAY DEPOTS AND WORKSHOPS

Administration	Maintenance Work done in Depots						Repair and other work done in Workshops								
							Periodical Repair Work						Casual Repair		Other
	Tractive Stock		Passenger Coaches		Goods Wagons		Tractive Stock		Passenger Coaches		Goods Wagons		Technical Incidents IT	Accidents RA	Modification Modernization Fabrication
	Category	Schedule	Category	Schedule	Category	Schedule	Category	Schedule	Category	Schedule	Category	Schedule			
OHATRA	periodic inspection VS minor maintenance PE minor casual rep.	every 60000 kms	inspection cleaning lubrication VGL	every 9 month	safety inspection minor casual repair	permanently due to bad treatment	medium maintenance ME intermediate overhaul RI general overhaul RG	every 120000 km every 240000 km 480000 km or after 2 years	general maintenance GE intermediate overhaul RI general overhaul RG	not specified mostly casual	overhaul 1 overhaul 2 overhaul 3 overhaul 4	not specified mostly casual	less than accidents	majority of work due to bad tracks, treatment mostly of wagons and coaches	change motors, bearings; brake system to compr. air; adapting imported coaches to operational cond.
ONCB	inspection and minor maintenance PE medium maintenance ME	not specified	inspection minor maintenance PE major maintenance GE	every 100.000 kms every 200.000 on 2 years	safety inspection minor casual repair	every 12 to 18 month depending on kind of bearing	intermediate overhaul RI general overhaul	on base of effect kilometers depending on type and provenance	intermediate overhaul RI general overhaul RG	every 400000 kms or 4 years every 800000 kms or after 8 years	overhaul 1 overhaul 2 overhaul 3 overhaul 4	every 2-3 every 4-6 every 6-8 every 8-12 years dep on bearings	difficulties indicated due to material not fit for operational conditions	often, due to bad tracks; decision to repair after analytic inspection	modernizations, fabricate brake shoes
KR	A B C D	depending on rules given by suppliers	light service A heavier service B	based on months of service depending on type	light service A heavier service B	based on month of service depending on type	general overhaul = E or F (only some types)	depending on type: line: every 156000 km general overhaul shunters: every engine 24000 hours		every 6 years	general overhaul	every 6 years	example 1981: locos 68 % coaches 26 % goods wagons 12 % of effected work	example 1981: locos 9 % coaches 11 % goods wagons 24 % of effected work	many self-fabrications of tools and parts; modification, modernization, fairly independent
ZK	inspection 1 inspection 2 ⋮ Light overhaul	every 15000 kms till 150.000	service	every 2,5 years	inspection service light overhaul	every 3 months every 9 month 5 every 2 1/2 years	intermediate overhaul IO general overhaul GO	every 450000 km every 900000 km	intermediate overhaul general repair	every 5 years every 9 years	"fair repair" "general repair"	every 5 years every 9 years	own department not specified, obviously minor percentage	own department; not specified obviously minor percentage	modernizations
SRC	safety visit inspection 1 inspection 2 inspection 3	weekly every 500 hours 3 = latest in 3 months	inspection + service	every 4 months	inspection + service	every 4 months	light overhaul heavy overhaul	every 10000 engine hours every 30000 engine hours	heavy overhaul	every 3 years	heavy overhaul	every 3 years	example 110 locos per year	example 6 locos DH year	modernizations modifications self-fabrications of bodies for coaches and wagons etc.
RAN	periodical inspection PE complete inspection VC	every 6500 kms every 100000 kms	only inspection	currently when possible	only inspection	yearly up to max. 3 years	medium maintenance MO intermediate overhaul RI general overhaul RG	every 200000 km every 400000 km every 800000 km	general maintenance GE intermediate overhaul RI general overhaul RG	yearly each 2nd year every 8 years	overhaul 1 overhaul 2 overhaul 3 overhaul 4	every 3 years every 6 years every 9 years every 12 years	example 2 incidents per loco during 100.000 kms run	example: in 3 months 83 locos and 30 coaches	modernizations modifications
SCFS	inspection small service on maintenance	every 4000 kms between 8000 and 32000 depending on type	only inspection	at least yearly	only inspection	yearly	major maintenance GE intermediate overhaul RI general overhaul RG	depending on type between 576000 to 2,300000 km and 200000 to 1,200000 km	general maintenance intermediate overhaul RI general overhaul RG	cycling every 200000 kms every 10 years	overhaul 1 overhaul 2 overhaul 3 overhaul 4	every 2 years each 4th each 6th 8 years	example: actually from 26 locos 2 in IT	example: actually from 26 locos 2 in repair due to accident	own "fabrication"-workshop; modernization modification
RCFM	small inspection current inspection general inspection	monthly every 3 months every 6 months	service	every 50000 km	special service	yearly	medium maintenance ME intermediate overhaul RI general overhaul RG	every 300000 km every 600000 km at 1,200000 kms	general maintenance GE intermediate overhaul RI general overhaul RG	every 100000 kms every 200000 kms every 600000 kms	overhaul 1 overhaul 2 overhaul 3 overhaul 4	every 2 years each 4th each 6th every 8 years	about 15 % of work	about 15 % of work	modernization modification some fabrications, for bodies

APPENDIX 5 : TABLE A : DETAILS UPON VISITED FACILITIES

Administration	Visited Facility				Responsable for Repair or Maintenance Work on					Equipment and storage	Work Procedure	Capacity per year (Example)	costs control	Output control	Remarks and Problems indicated
	Kind	place	Date of Constr	Total staff	Line Locomotive	Shunters	Railcars	Passenger Coaches	Goods Wagons						
OKATRA	Depot	Kinshasa	1930		X		X			cubit old-fashioned and too small	object standing, parts dismantled, repaired or interchanged and refitted	mainly light over hauls of line locos	men power and used spare parts per object	receptioning inspection ↓ static tests ↓ line test ↓ 15 days under observation in service	heavy lack of spare parts and interchangeable units; delivery terms up to 2 years currency problems some renewals of tool machinery required thefts of material problems with imported material
	Workshop	Kinshasa	1930 1962			X		X	X	fair; the new hall with very good tool machinery also highly specialised central and section stores	certain on-line procedure to different sections as far as available use of interchangeable parts and units	many exchanges of Diesel motors 20 general overhaul on passenger coaches up to 2000 overhauls on goods vans 80 modifications to container vans			
OCBK	Workshop	Cotonou	1940 — 1960	750	X	X	X	X	X	fair, according to information by Mr. Sahouegnon central store and substores, also providing depots	objects standing parts given for repair to sections; use of method of interchangeable parts and units	10 general overhauls on locos 10 general overhaul on pass. coaches high rate of casual repairs specially goods wagons due to uncareful handling	office for work organisation (BOT) follows each object estimation of man hours; really used spare parts	inspection and measures ↓ static test ↓ line test (alone, later in train)	storage of spare parts and interchangeable units difficult due to small series no greater problems with suppliers, they show co-operation
KR	Central Workshops E.A.R.	Nairobi	started 1899	2800	X	X	X	X	X	very great facility basically divided into loco and wagon shop with a lot of concerning sub-sections, also highly specialised for self-fabrication of tools or instruments, own laboratory central store and substores for sections, also providing KR-depots many self-fabrication separated section for maintenance of workshop	on-line-method components pass specialised sections use of interchangeable units and method very well-devised	on locos: 29 general overhauls 88 technical incidents 12 accidents coaches: 330 general overhauls 135 technical incidents 60 accidents goods stock 2800 general overhauls 540 technical incidents 1050 accidents	own department foregiven tires for procedures manpower and used spare parts control	own section workshop test ↓ line test alone ↓ line test under operational conditions	no special problems indicated; work also done for third parties outside KR and other linking railway network (E.A.R.) good policy in well-timed supply to storage

APPENDIX 5 : TABLE B (cont) DETAILS UPON VISITED FACILITIES

Administration	Visited Facility: Kind	Visited Facility: Place	Visited Facility: Date of Const.	Visited Facility: Total Staff	Responsable for Repair or Maintenance on: Line Locomotive	Shunters	Railcar	Passenger Coaches	Goods Wagons	Equipment and Storage	Work Procedure	Capacity per Year (Example)	Costs Control	On-Put Control	Remarks and Problems indicated
ZR	central workshop	Kabwe	1970	550	X	X	X	X	X	no detailed information highly specialised sections for components, casual repair, periodical overhaul, overhaul instruments and electronics well-devised	for locos: object remains on place, parts dismanteled, exchanged or repaired and refitted for coaches and vans: on-line-system	locos 12 intermediate overhauls 10 heavy overhauls coaches 60 general overhauls goods stock about 3000 overhauls	man hours and used parts	workshop certifiontion ↓ 3 inspections in depots ↓ in service under observation	different work procedures as rewinding of motors or difficult work on Diesels must be given to outside enterprises. claims of bad quality . difficulties with spare parts due to long terms of delivery (6 to 24 months) and non-availability
SRC	loco depot	Khartoum		50	X					prepared for time-inspection engine-check some casual repairs	object standing parts exchanged use of interchangeable components only partly	about 140 minor casual repairs current check of 22 line locos of central region	man hours and spare parts	static test rig	problems with equipment and tool machines lifting devices, lack of spare parts and interchangeable units. currency problems; if money then long terms of delivery
	workshop	Khartoum	partly 1960	500		X	X	X	X	technical sections with fair tool machine equipment for different components or procedures	in principle on-line-method with use of interchangeable units	many modifications (braking system) (body-building) coaches: 360 general overhauls goods stock: up to 500 heavy overhauls	man hours through foremen and spares	static tests and measurements ↓ test run ↓ service	problems with newly imported vehicles of 22 locos 12 standing due to lack of spare parts; general lack of spare parts to facility equipment and rolling stock as for loco depot "cannibalizing"-method often necessary
RAN	workshop		1904 - 1956	500	X	X	X	X		equipment partly old and, due to lack of spare parts, not in service technical sections for the different procedures on different parts and components central store supplying substores and RAN-depots	object remains generally in place, partly use of method of interchangeable components, otherwise repair piece by piece	apart from modifications and modernisation locos 26 medium maintenances 4 intermediate overhauls 4 general overhauls railcars about as for locos coaches 20 intermediate overhauls 32 general overhauls	office for work organisation (BOT) controlling manhours and used spares	static tests and measurements ↓ line test	some high-qualified work must be ordered outside (winding, instruments, around Diesel cylinders) about 50 % of rolling stock standing due to lack of spare parts for vehicles and tool machines of facility see appendix 3. The general managers indicated, that under this circumstances, RAN must close the doors within 1 year from now. Own office for technical studies.

APPENDIX 5 TABLE C : DETAILS UPON VISITED FACILITIES

Admini-stration	Visited Facility				Responsable for Repair or Maintenance of					Equipment and Storage	Work Procedure	Capacity per year (Example)	Costs Control	Out-Put Control	Remarks and Problems indicated
	Kind	Place	Date of Const	Total Staff	Line Locomo-tive	Shunters	Railcars	Passen-ger Coaches	Goods Wagons						
RCFS	workshop	Tries	1885 - 1923	900	X	X	X	X	X	separate technical sections and equipment for all main work procedures in parts and components central store with a storage rate of about 5 to 10 % of needed parts and components	objects remain on one place dismantled parts exchanged or repared	apart from medifications and modernizations many casual repairs due to technical incidents and accidents periodic overhaul not specified (approximately like Bamako)	manhours and really used spares	static testing ↓ 15 kms test run ↓ on line but under control	10 % of locos sick due lack of spare parts sometimes problems with highly spezialised small spare parts or spares for tool machines and equipment from 112 coaches only 12 modern ones and from the rest often only 20 % apt. for traffic, too low salaries; generally independent, nearly no work ordered outside
RCFM	workshop	Bamako	1970	300	X	X	X	X	X	sections for all main work procedures equipment fair, partly tool machines and lifting devices out of service due to lack of spares some sections need strenghtering	objects remain on one place dismantaled parts exchanged or repared partly use of interchangeable components, but not all available	for locos + rail-cars 8 medium maintenance 5 intermediate overhauls 4 general overhauls 40 accidents for coaches 240 general maintenances 14 intermediate overhauls 6 general overhauls 6 accidents for goods stock 36 overhauls number 4 36 accidents many modifications of bodies	office for work control (BOT) manhours through foremen and used spares	static tests ans measurements ↓ line test alone ↓ back to service certain time under depot control	forced to send some rolling stock to repair work to Senegal (Thies) due to lack of spares in equipment some higher leved work must be ordered outside, problems with imports from far-abroad terms of delivery 6 - 18 months and money require of modern material control methods claim, that newly ordered rolling stock is not enough robust to cover operational conditions too low salaries